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## FIVE YEARS OF THE PANAMA CANAL: AN EVALUATION\*

By ROBERT M. BROWN

The Panama Canal was opened to traffic on August 15, 1914. During the three hundred years since Balboa, the advantages which would follow the completion of the project have been enumerated time and again. Some of these were obvious, such as the shortening of the sea route between New York and San Francisco, while others were more obscure and only prophetically demonstrable, such as the increased use of the Mississippi River waterway. The traffic between the eastern and the western shores of the Americas, never so large as that between the western and eastern shores of the Old World, which resulted in the building of the Suez Canal, was subject to a problematical increase under a shortened sea way, but, over and above this, facilities for the quicker movement of the navy of the United States from its Atlantic to its Pacific seaboard or vice versa were of paramount importance. In this latter argument, the canal might be considered a paying investment regardless of costs and revenues. The canal was opened for traffic a few days after the world war began. In spite of the falling off in commerce due to the war, the canal became a paying investment from the standpoint of actual earnings before the armistice was signed.

Another phase of the canal question which is most amazing is the transformation of the zone from a pestilential area of difficult and dangerous travel to a land where the death rate is less than that of some of our large cities, as well as to a land of well-paved roads and bountiful crops. Some of these results have been beyond the dreams of the most sanguine adherents of canal construction, and the history of the last few years during which the United States has been in charge of the Canal Zone is a record of remarkable achievements.

Catastrophe and disaster are still prophesied as imminent by those who believe that slides and earthquakes have not registered their maximum expression; but, while these are always possible, they appear from the records of the last few years to be fairly remote contingencies, more serviceable as propaganda against the efficiency of the canal than as actual warnings.

The following notes, taken from the annual reports of the Governor of the Panama Canal, give one a résumé of actual operations for a period of years. By means of the results so far achieved we can now test the validity of the earlier theoretical analyses of the value of the canal and gain a clearer idea of its future importance.

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\* For an account of the canal shortly before its completion, see J. W. Herbert: *The Panama Canal: Its Construction and Its Effect on Commerce*, *Bull. Amer. Geogr. Soc.*, Vol. 45, 1913, pp. 240-254, with map in 1:660,000.—EDIT. NOTE.

## REVENUE

The tolls levied on vessels passing through the Panama Canal since the opening of the canal (August 15, 1914) to July 1, 1919, amounted to \$28,475,285.85. Of this amount a part is uncollectible, as shown below, leaving as the actual revenue of the canal from tolls the sum of \$24,810,499.11. Appropriations by Congress for canal purposes up to this time have been \$459,443,105.99. For the fiscal year ending June 30, 1919, the tolls collected reached the sum of \$6,156,118.95; and the total revenues the sum of \$6,354,016.98. The canal authorities claim a loss during the year of \$867,526.48—because of a difference between the Panama Canal rules for the measurement of the tonnage of vessels and the rules as laid down by the United States statutes—and a total loss of \$3,664,786.74 since the opening of the canal.<sup>1</sup> The main point of divergence in the two sets of rules has reference to the open deck cargo. The Panama Canal rules provide that on vessels carrying stores, timber, cattle, and other cargo on open deck spaces the tolls which are payable on the vessel's net tonnage shall be increased by the tonnage of space occupied by the goods on deck. This ruling was felt particularly by the lumber interests of the Pacific Coast, and upon their protest the Attorney General of the United States decided that the measurement of vessels must be in accordance with the United States rules and that tolls levied in excess at Panama are not collectible. The Panama Canal rate of \$1.20 per net ton—each 100 cubic feet of actual earning capacity—was higher, in many instances, than the National rate of \$1.25 per ton of net capacity. The difference between these two tonnage rates has (as stated above) amounted to \$3,664,786.74, which the authorities at the canal report as a loss but which under the circumstances has no potential value.

For the year ending June 30, 1918, the revenue earned was for the first time in excess of the expenses, leaving a balance in favor of the canal management of \$697,556.23. The previous year the expenses exceeded the revenue by \$979,648.90;<sup>2</sup> and to July 1, 1919, the expenses have been in excess of the revenue by \$4,618,690.75. During the last fiscal year the revenues were in excess of current expenses by \$241,822.21.<sup>3</sup> The increase of revenue from tolls and the maximum yearly revenue which could be confidently looked for with a normal increase each year in the number of vessels using the canal depend at present on the possible number of lockages which can be permitted by the available storage capacity of the reservoirs.

## VESSELS USING THE CANAL: PRESENT AND FUTURE

The average number of lockages made at all locks for each month of the fiscal year ending June 30, 1918, was 195.39, or about 6.5 through lockages

<sup>1</sup> *Ann. Rept. Governor of the Panama Canal for the Fiscal Year Ended June 30, 1919, Washington, D. C., pp. 22, 170, 188.*

<sup>2</sup> *Ibid.*, 1918, pp. 26, 186, 205.

<sup>3</sup> *Ibid.*, 1919, p. 188.

per day. The greatest number of lockages made in any month occurred in May, when the Atlantic locks made 229 and the Pacific locks 225. During the year, a total of 2,130 vessels<sup>4</sup> passed through the canal with an average for three stations, Gatun, Pedro Miguel, and Miraflores, of 2,345 lockages.<sup>5</sup> This average for the year ending June 30, 1919, fell to 2,313.<sup>6</sup> The number of ships passing through the canal exceeds the number of lockages because of the possibility at times of passing more than one ship through in a single lockage.

This number of lockages did not tax severely the storage capacity of Gatun Lake. In general it is planned to have this lake at or near its maximum allowable elevation, plus 87 feet, at the beginning of the dry season, which roughly includes the first four months of the calendar year. During the fiscal year ending June 30, 1918, the elevation of the lake was plus 87.06 feet at the beginning of January, and this level had not been lowered appreciably on February 1. The minimum elevation for the year occurred on April 21 at plus 84.52 feet.<sup>7</sup> For the year ending June 30, 1919, the maximum elevation occurred in January, when the water stood at plus 85.56. The minimum elevation, in April, was 84.15 feet.<sup>8</sup> Practically all the water above plus 80 feet is available for use. The bottom of the canal through the lake is 40 feet above sea level, and the lowering of the lake below plus 80 feet would reduce the depth of water for floatments below 40 feet. It was estimated that the water in the lake not used during the dry season of 1918—that is the water between plus 84.52 feet and plus 80 feet—even with allowances for proportionate depletion for other things than lockages was sufficient to provide for 15 complete canal lockages daily instead of the 6.5 daily average which was actually made. A large part of the water depletion as shown below is fed to the hydro-electric generating plant; and it was further estimated that by conserving the amount furnished for this purpose the upper limit of lockages might be increased to 36 a day.

The maintenance of the water level of Gatun Lake above plus 80 feet depends on the available supply yielded by the hydrographic basin, the consumption for canal purposes, the depletion other than consumption, and the further possibilities for water storage.

The rainfall over the Gatun watershed has averaged for thirteen years 126.45 inches a year.<sup>9</sup> The three driest months—January, February, and March—have a monthly average of 2.8 inches. Of the waters of the lake lost or consumed during the fiscal year, about 69 per cent went in spillway discharge. During nine months of the year, the water is in excess of the demands for all purposes and has to be freed; it is only during the dry period of three and a half months that the rainfall is insufficient to meet the needs of the canal and the auxiliary plants. Thus a storage capacity in the lake is necessary, and the footage between plus 80 feet and plus 87 feet,

<sup>4</sup> *Ann. Rept. Governor of the Panama Canal for the Fiscal Year Ended June 30, 1918*, Washington, D. C., pp. 135, 137.

<sup>5</sup> *Ibid.*, 1918, p. 44.

<sup>6</sup> *Ibid.*, 1919, p. 42.

<sup>7</sup> *Ibid.*, 1918, p. 45.

<sup>8</sup> *Ibid.*, 1919, p. 43.

<sup>9</sup> *Ibid.*, 1918, p. 86.

until other arrangements are made, must tide over until the rain becomes heavy. No immediate need of extra storage seems imminent.

The consumption of water for lockages during a year is only 7 per cent of the total lost or used. Next to the spillway discharges from the excessive rains (69 per cent), the hydro-electric station uses the greatest amount of water, 14 per cent of the total. About 9 per cent is lost by evaporation, and the remaining 1 per cent is divided among leakages, transfers, and pumping.<sup>10</sup> Altogether about 78 per cent of the water flowing out of the Gatun watershed during the last fiscal year was lost, that is was not used for any purposes relating to the canal; only 22 per cent was actually consumed on the plant projects. There is water enough for additional storage. In case lockages during any dry season drain the lake level to plus 80 feet, it is the plan to feed less to the hydro-electric plant and thereby save water in storage for actual ship floatments. The maintenance engineer of the canal is of the opinion that during an average year it will be possible to operate the hydro-electric station at full projected capacity, using 3,260 cubic feet of water per second, and take care of about 21 complete canal lockages daily throughout the dry season without utilizing additional storage. With any increase in this estimate of daily lockages, water will have to be drawn from the allowance of the power plant. "With 36 canal lockages daily during the driest year of record, it will be necessary to cut the water used for power development to about 900 cubic feet per second throughout the dry-season months, which is sufficient to operate the hydro station at about 25 per cent of its full projected capacity."<sup>11</sup> The future increase of the canal traffic up to this optimum will have to be met in one of two ways: either by using the auxiliary steam plant in place of the hydro-electric station during the dry season so as to conserve water or by finding a way to impound more of the water of the wet season which is lost by spillway discharges.

During the year ending June 30, 1919, about 40 per cent of the total number of vessels passing through the canal were from the United States; 30 per cent were British; 6 per cent Norwegian; 5 per cent French; and 4.5 per cent Chilean; the rest were mainly Japanese, Danish, and Peruvian. The gross tonnage was 7,876,703.<sup>12</sup> For 1914 the gross tonnage passing through the Suez Canal was 26,866,340.

#### SLIDES

The canal up to July 1, 1919, has been closed by obstructions due to slides 242 days out of a possible 1,537 days. Of this time 210 days were a consecutive period lasting from September 18, 1915, to April 15, 1916. Of the entire length of the canal, about 35 miles between mean tide levels, only the portion between the Pedro Miguel locks, the highest on the Pacific side,

<sup>10</sup> *Ann. Rept. Governor of the Panama Canal for the Fiscal Year Ended June 30, 1918*, Washington, D. C., p. 45.

<sup>11</sup> *Ibid.*, 1918, p. 93.

<sup>12</sup> *Ibid.*, 1919, pp. 119, 120.

and Bas Obispo, near Gatun Lake, is subject to slides. This cut across the highest part of the Isthmus, formerly called Culebra Cut and now officially called the Gaillard Cut after the late David Du Bose Gaillard, one of the leading engineers of the canal, passes through rock for  $8\frac{3}{4}$  miles; and of the Gaillard Cut only about 2,800 feet at Culebra Hill and 2,000 feet at Cucaracha Hill have been troublesome slide locations. Two and one-half per cent of the entire length of the canal, therefore, or about ten per cent of the Gaillard Cut constitutes the length affected by slides. The slides caused by the slipping down of loosened earth on steep slopes are small in extent and relatively insignificant; the more common type of slides in the Gaillard Cut have apparently resulted from the unbalancing of the established equilibrium in digging the canal. The lateral support of the hills on both sides of the canal in the Culebra district was, considering the peculiar nature of the native rocks, more important than had been determined in the original specifications. When this support was removed, the weight of the hills on each side of the Gaillard Cut in the Culebra district was sufficient to cause a movement outward from the hills into the canal where the pressure had been removed. Coincident with the lateral movement of the banks into the canal an elevation of the bottom of the canal, due probably to the same cause, occurred. Thus on September 18, 1915, the date of the beginning of the big slide, both banks began a strong movement into the canal prism; and on the next day an island, the result of upheaval, appeared in the canal. At its greatest height, the obstruction in the canal, during this slide, covered a distance of 255 feet of canal length, and the débris stood 65 feet above the mean water level in the canal.<sup>13</sup>

It is not so much the purpose here to enter into the details of slide causes as to state, as fairly as can be determined, the conditions which may affect the use of the canal as a waterway. The closing of the passage for 232 days in a single year so soon after the opening of the canal tended to destroy confidence in a sure and safe passage through it. The wide publicity given to the slides in papers and magazines emphasized the accident as a recurrent feature rather than as an unusual phenomenon. During November, 1915, at the request of the President of the United States, a committee of the National Academy of Sciences was appointed to consider the possibilities of controlling the slides. The final paragraph of their preliminary report is quoted:<sup>14</sup>

The committee looks to the future of the canal with confidence. It is not unmindful of the labor necessary to deal with the present slides; and it realizes that slides may be a considerable, but not an unreasonably large maintenance charge upon the canal for a number of years; it also realizes that trouble in the Culebra district may possibly again close the canal. Nevertheless, the committee firmly believes that, after the present difficulties have been overcome, navigation through the canal is not likely again to be

<sup>13</sup> *Ann. Rept. Governor of the Panama Canal for the Fiscal Year Ended June 30, 1916*, Washington, D. C., p. 32.

<sup>14</sup> *Ibid.*, 1916, p. 598.

seriously interrupted. There is absolutely no justification for the statement that traffic will be repeatedly interrupted during long periods for years to come. The canal will serve the great purpose for which it was constructed, and the realization of that purpose in the near future is assured.

The committee bases this confident conclusion of their investigations on the fact that the soft rock which has been the primary cause of the slides is limited in extent and that the harder rock has displayed no tendency to move. Since their investigations, the history of slides in the canal has been in accord with these findings.

At the end of the next fiscal year, June 30, 1917, in summing up the report on slides, it is found that the Cucaracha slide became active late in August, 1916, and traffic was suspended through the canal for a period of eight days ending September 7; and that the Culebra slide was fairly active during the year but was not sufficiently so to close the canal except for two days, January 10 and 11, 1917.

At the end of the fiscal year ending June 30, 1918, the Cucaracha slide is reported to have been at no time a menace to navigation, and the Culebra slide, although it continued its action, did not at any time close the channel or delay shipping. There is a promise of making this district permanently free from slides by a small (in comparison with what has been removed) additional amount of earth removal. During this year another unstable region near West Culebra menaced navigation, but the trouble was discovered and remedied before becoming serious. No "difficulty in maintaining full width and depth of the channel in the Culebra slide region"<sup>15</sup> is the report for the year ending June 30, 1919.

In concluding this survey of the slides, it is safe to assert that accidents to the canal from this cause may be confidently expected to be fewer and fewer. It would be fortunate indeed if no further blockage of the waterway by slides were to be recorded; but this is perhaps too much to hope for. The canal is not yet out of danger from this cause of obstruction; but it is apparently out of danger of a prolonged period of closing.

#### EARTHQUAKES

The entire Isthmus is in an area subject to seismic disturbances, and the threat of a severe earthquake hangs over the whole Canal Zone. It is impossible to forecast the expectable damage in case of a severe earth shake. The records during the last few years demonstrate little more than the fact that earth shakes are common. For the year ending June 30, 1916, there were recorded 59 tremors, practically all of them of local origin. The heaviest did considerable damage to the wharf of the United Fruit Company at Bocas del Toro. This shock was recorded as V on the Rossi-Forel scale of I to X and in translation would read "shock of moderate intensity." During the following year 32 tremors were recorded, of which seven were of distant origin, the epicenters ranging more than 1,000 miles away. The

<sup>15</sup> *Ann. Rept. Governor of the Panama Canal for the Fiscal Year Ended June 30, 1919, Washington, D.C., p. 15.*

heaviest shock recorded had an intensity of IV, which is translated as "feeble." For the year ending June 30, 1918, 30 disturbances were recorded, and the heaviest shock had an intensity of III (very feeble). For the next year, 46 disturbances were noted, all slight tremors from shocks of distant origin.

#### SANITATION

The canal in its future possibilities must render an almost unbroken passageway not only free from danger of a physical nature but also free from the danger of encountering contagious diseases. The work of the Health Department, therefore, is as necessary and must be as effective as that of the Engineer of Maintenance. The achievement of this sanitary department is a notable one, and a traveler may be assured of a safe transit of the Canal Zone so far as tropical diseases are concerned. The French kept no record of their sick rate during the years from 1881 to 1889, but it has been estimated at one-third of their force, or 333 per 1,000. The American rate was 23 per 1,000 per day during the ten years of construction with a force of 39,000 men. During the same period the death rate among employees was 17 per 1,000; which made about 663 deaths per year. The French rate was 200 per 1,000. In 1906, when the malaria rate was the highest, 821 persons out of every 1,000 were admitted to the hospitals suffering with this disease. In 1913 this rate had been reduced to 76. In 1916 the rate was 34; in 1917, 13.47; and in 1918, 20 per 1,000. The death rate for the year ending June 30, 1916, from all causes was 23.53 per 1,000; for the next year 23.46; and the next 22.21; and for the year 1918-1919 it was 20.44. When it is considered that the death rate in the United States is about 16 per 1,000 (ranging from 22 in cities to 14 in rural districts), one feels safe in asserting that danger from diseases in the Canal Zone area has been reduced to a minimum. The labor expended in accomplishing this wonderful result has been large, and it is only maintained by vigilance and untiring care. During 1918, for instance, bubonic plague raged along the South American coast from Valparaiso northward; yellow fever was spreading through Guayaquil and the surrounding country; smallpox broke out in Bluefields, Nicaragua, and in Cartagena, Colombia; and the plague was rampant in Venezuela. All these places were points of call for vessels bound through the canal, yet no case of plague, smallpox, or yellow fever was reported in the Canal Zone. The quarantine stations protecting the entrances to the canal are sufficient safeguards against all these conditions. The tables of quarantine service show for the ports of Panama and Colon for 1919 that 174,194 persons were inspected, 6,882 persons vaccinated, and 17,254 persons held in quarantine. The conclusion of the matter appears to be that there is some danger of contracting disease in the passage to the canal (increasing in proportion to the number of calls the vessel makes) and that there is very little danger from contagious diseases in the canal district. It is an evidence of the efficiency of this service that



the influenza, which swept the world during the last months of 1918, was little felt in the Canal Zone; this was due probably to the special quarantine against influenza.

#### ECONOMIC OPPORTUNITIES OF THE CANAL ZONE

With the eradication of the dreaded tropical diseases from the Isthmus, the Canal Zone and its neighborhood should attract settlers; particularly as the opportunities for raising tropical products appear alluring. During 1917 Panama City alone exported bananas to the value of two and a half million dollars; coconuts to the value of three-fourths of a million; balata, half a million; hides, a third of a million; and many other native products in smaller values.

The assets in the Republic of Panama may be briefly summarized:

(1) Topography. There is within a short distance a range of altitudes which will furnish resorts for persons not accustomed to the tropical climate. The land may be considered as about one-third semi-tropical (altitudes ranging from 2,000 to 6,000 feet) and about two-thirds tropical. It is estimated that there are about 3,000,000 acres of land above 3,000 feet which, when made accessible by good roads, will be suitable for colonizers of the white race.

(2) Production. The yield of coconuts, ivory nuts, balata, bananas, and native woods is far short of the possibilities. Verner<sup>16</sup> states that in Panama there are 2,000 square miles of coconut lands capable of sustaining 100,000,000 trees yielding a yearly product worth \$200,000,000; that the yield of ivory from wild palms is far below the available, and cultivation would increase the output thirty fold; and that there are 5,000,000 acres suitable for the cultivation of bananas which would yield at a conservative estimate \$400,000,000 as against \$2,000,000 in 1917. Whether or not such estimates are easier on paper than on the Isthmus, there appears to be good ground for considering an immediate increase in the exports likely. Shipments would of course be a relatively simple matter.

It is not surprising that in an area so advantageous for crop production the supply department of the Canal Zone is reducing the dependence of the population upon outside sources for foodstuffs. During recent years, it has been possible to supply the inhabitants and the steamships passing through the canal with beef and pork products without importations of this staple. Chicken and dairy farms are maintained. Under the control of the supply department, there are thirteen plantations which have provided a sufficient quantity of fruits and vegetables for local consumption.

Altogether, the people of the United States can look to the achievements at Panama with pride. Many of the lines of endeavor here brought to a successful fruition are examples of skillful management and trusteeship that have been wrought without the aid of previous experience. The workers have in these lines blazed a new trail for the nations of the earth.

<sup>16</sup> S. P. Verner: Panama—Past, Present, and Future, *Bull. Pan Amer. Union*, Vol. 48, 1919, pp. 125-144, Washington, D. C.